09/066383

PATENT COOPERATION TREATY

EINGEGANGEN
- 3. Nov. 1997

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

PCT Erl.....

To:
Sulzer Management AG
KS/Patente/0007
Zürcherstrasse 12
CH - 8401 Winterthur
SUISSE

NOTIFICATION OF TRANSMITTAL OF INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing *(day/month/year)*	30. 10. 97

Applicant's or agent's file reference	IMPORTANT NOTIFICATION
P.6765/EHPH	

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/IB 96/01156	28/10/1996	31/10/1995

Applicant

SULZER CHEMTECH AG et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices)(Article 39(1))(see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. (+49-89) 2399-0, Tx: 523656 epmu d Fax: (+49-89) 2399-4465	Jean-Philippe Gregoire Telephone No. 701/

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
P.6765/EHPH		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/IB 96/01156	28/10/1996	31/10/1995
International Patent Classification (IPC) or national classification and IPC		
B01J19/32		
Applicant		
SULZER CHEMTECH AG et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consists of a total of _____ sheets.

3. This report contains indications and corresponding pages relating to the following items:

   I ☒ Basis of the report

   II ☐ Priority

   III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

   IV ☐ Lack of unity of invention

   V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

   VI ☐ Certain documents cited

   VII ☐ Certain defects in the international application

   VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
05/03/1997	30.10.97
Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. (+49-89) 2399-0, Tx: 523656 epmu d Fax: (+49-89) 2399-4465	G. Büsing
	Telephone No.

Intern. application No.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT PCT/IB96/01156

I. Basis of the report

1. This report has been drawn up on the basis of (Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.):

[x] the international application as originally filed.

[ ] the description, pages _____, as originally filed,
pages _____, filed with the demand,
pages _____, filed with the letter of _____,
pages _____, filed with the letter of _____,

[ ] the claims, Nos. _____, as originally filed,
Nos. _____, as amended under Article 19,
Nos. _____, filed with the demand,
Nos. _____, filed with the letter of _____,
Nos. _____, filed with the letter of _____,

[ ] the drawings, sheets/fig _____, as originally filed,
sheets/fig _____, filed with the demand,
sheets/fig _____, filed with the letter of _____,
sheets/fig _____, filed with the letter of _____.

2. The amendments have resulted in the cancellation of:
[ ] the description, pages _____.
[ ] the claims, Nos. _____.
[ ] the drawings, sheets/fig _____.

3. [ ] This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

1. STATEMENT

Novelty (N)	Claims _____	YES
	Claims 1, 2, 8, 9, 12, 13	NO
Inventive Step (IS)	Claims _____	YES
	Claims 3 - 7, 10, 11, 14	NO
Industrial Applicability (IA)	Claims 1 - 14	YES
	Claims _____	NO

2. CITATIONS AND EXPLANATIONS

1. The following documents (D) are relevant:

D1 ..... Patent Abstracts of Japan, vol. 94, no. 011 & JP-A-06312101
D2 ..... DE-A-4 122 369
D3 ..... CH-A-666 199
D4 ..... DE-B-1 253 673
D5 ..... US-A-5 013 492

Each of these documents discloses a fluid-fluid contacting apparatus with a structured packing comprising a number of packing elements arranged in succession in the designed direction of flow.

2. Document D1 comprises a number of layers as defined in the first part of claim 1 and has means at the interface between successive elements for reducing the pressure drop imposed on the continuous phase a the interface. This is achieved, according to D1, by either introducing liquid flow acceleration means (101, 102, 103) between

adjacent packing elements or by modifying the shape of the layer material of the packing element at the lower end of the packing element.

Consequently, D1 takes away the novelty of the subject-matter defined in claims 1, 2, 8, 9 and 12.

3. Document D2 also discloses the provision of means for reducing the pressure drop at the interface between adjacent packing elements. These means may constitute the end portion of a packing element (column 2, lines 44 - 53).

D2 anticipates the subject-matter of claims 1 to 4, 8, 12 and 13.

4. D3, D4 and D5 are of similar relevance. D3 teaches to provide intermediate plates between the packing elements; see in particular claims 1 to 6 of D3. D4 proposes to introduce gaps between the packing elements (see the paragraph bridging columns 5 and 6) and D5 also suggests to modify the end portions of the packing elements (see abstract).

5. The problem of the pressure drop at the interface between adjacent packing elements has obviously be known before, and the solutions suggested in the available prior art are those defined in the claims referred to above. In view of this prior art teaching, it is obvious for the ordinarily skilled worker to modify the known solutions to the problem, according to the circumstances, without the exercise of an inventive skill. It appears that such normal routine work would result in the modifications as defined in the remaining dependent claims.

Therefore, it is not apparent how the features of the

remaining dependent claims or of the description could support an inventive step.

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

1. Claim 3 lacks clarity because the "angle of obliquity" is not defined. It should be made clear in the claim how this angle is defined; see for example paragraph 3 of page 1 ("to the horizontal").

2. Claims 8 to 12 lack clarity. The fluid flow control means according to claim 8 is vague and indefinite. According to claim 9, it may be located in the gap or, according to claims 10 and 11, it may be the gap itself.

3. Independent claim 12 lacks clarity. The claim relates to an apparatus (packing element) but is partly defined by process features ("the localised change in configuration is effective to reduce the pressure drop imposed on the continuous phase at the interface"). Such result features are not suitable for defining an apparatus, which should rather be done by constructional features.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
P.6765/EHPH		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/IB 96/01156	28/10/1996	31/10/1995

Applicant

SULZER CHEMTECH AG et al.

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. [ ] **Certain claims were found unsearchable** (see Box I).

2. [ ] **Unity of invention is lacking** (see Box II).

3. [ ] The international application contains disclosure of a **nucleotide and/or amino acid sequence listing** and the international search was carried out on the basis of the sequence listing
   - [ ] filed with the international application.
   - [ ] furnished by the applicant separately from the international application,
     - [ ] but not accompanied by a statement to the effect that it did not include matter going beyond the disclosure in the international application as filed.
   - [ ] Transcribed by this Authority

4. With regard to the **title,**
   - [ ] the text is approved as submitted by the applicant.
   - [X] the text has been established by this Authority to read as follows:

   STRUCTURED PACKING.

5. With regard to the **abstract,**
   - [ ] the text is approved as submitted by the applicant.
   - [X] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this International Search Report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is:

   Figure No. 2 [X] as suggested by the applicant. [ ] None of the figures.
   - [ ] because the applicant failed to suggest a figure.
   - [ ] because this figure better characterizes the invention.

Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

Fluid-fluid contacting apparatus (10) is provided with a structured packing comprising a series of packing elements (20) fabricated from sheets (24) of crimped material in such a way that the corrugations (26) in each sheet (24) extend obliquely with respect to the direction of bulk fluid flow through the apparatus (10). Each packing element (20) is oriented with the sheets (24) thereof in a plane which is angularly displaced with respect to the sheets (24) of neighbouring elements (20). Means is provided at or in the vicinity of the interface (21) between neighbouring elements (20) for reducing the pressure drop imposed on the continuous phase as it passes from one element (20) to the next.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB 96/01156

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B01J19/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE,C,41 22 369 (RAINER RICHTER GMBH) 22 October 1992 see abstract see column 2, line 44 - line 53 see column 3, line 35 - line 64 see figures	1-4,8, 12,13
A	---	5
X	US,A,5 013 492 (MUNTERS CORPORATION) 7 May 1991 see abstract see column 1, line 62 - line 66 see column 2, line 15 - line 19 see column 2, line 59 - column 4, line 9	1,2,8,12
A	---	
	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 January 1997	31. 01. 97

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Stevnsborg, N

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE,B,12 53 673 (GEBRÜDER SULZER AKTIENGESELLSCHAFT) 9 November 1967 see column 5, line 21 - column 6, line 3 see figures	1,2,8,9, 12
A		10,11
X	PATENT ABSTRACTS OF JAPAN vol. 94, no. 011 & JP,A,06 312101 (HITACHI LTD.), 8 November 1994, see abstract; figures & DATABASE WPI Section Ch, Week 9504 Derwent Publications Ltd., London, GB; Class E11, AN 95-027321 & JP,A,06 312 101 (HITACHI LTD.) , 8 November 1994 see abstract	1,2,8,9, 12
A	CH,A,666 199 (GEBRÜDER SULZER AKTIENGESELLSCHAFT) 15 July 1988 see page 3, right-hand column, line 62 - page 4, right-hand column, line 4 see figure A	1,2,8,9, 12
A	US,A,4 225 540 (CARL MUNTERS-EUROFORM) 30 September 1980 see the whole document	1,2,6-8, 12,14
A	EP,A,0 401 682 (MUNTERS EUROFORM GMBH) 12 December 1990 see abstract see column 2, line 19 - line 22 see column 2, line 39 - line 53 see figures	1,3-5, 12,14

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
DE-C-4122369	22-10-92	WO-A-	9402794	03-02-94
		AU-A-	2344792	14-02-94
US-A-5013492	07-05-91	NONE		
DE-B-1253673		CH-A-	398503	
		FR-A-	1362274	11-09-64
		GB-A-	1004046	
		NL-C-	131987	
		NL-A-	284535	
CH-A-666199	15-07-88	AU-A-	6797987	30-07-87
		DE-U-	8700639	12-03-87
US-A-4225540	30-09-80	NONE		
EP-A-0401682	12-12-90	DE-A-	3918483	13-12-90
		ES-T-	2044316	01-01-94
		US-A-	5124086	23-06-92

09/066383

PATENT COOPERATION TREATY

PCT

REC'D 03 NOV 1997
WIPO PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
P.6765/EHPH		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/IB 96/01156	28/10/1996	31/10/1995
International Patent Classification (IPC) or national classification and IPC		
B01J19/32		
Applicant		
SULZER CHEMTECH AG et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consists of a total of _____ sheets.

3. This report contains indications and corresponding pages relating to the following items:

   I ☒ Basis of the report

   II ☐ Priority

   III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

   IV ☐ Lack of unity of invention

   V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

   VI ☐ Certain documents cited

   VII ☐ Certain defects in the international application

   VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
05/03/1997	30.10.97
Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. (+49-89) 2399-0, Tx: 523656 epmu d Fax: (+49-89) 2399-4465	G. Büsing Telephone No.

Intern. application No.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT PCT/IB96/01156

I. Basis of the report

1. This report has been drawn up on the basis of (Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.):

[x] the international application as originally filed.

[ ] the description, pages _____, as originally filed,
pages _____, filed with the demand,
pages _____, filed with the letter of _____,
pages _____, filed with the letter of _____,

[ ] the claims, Nos. _____, as originally filed,
Nos. _____, as amended under Article 19,
Nos. _____, filed with the demand,
Nos. _____, filed with the letter of _____,
Nos. _____, filed with the letter of _____,

[ ] the drawings, sheets/fig _____, as originally filed,
sheets/fig _____, filed with the demand,
sheets/fig _____, filed with the letter of _____,
sheets/fig _____, filed with the letter of _____.

2. The amendments have resulted in the cancellation of:
[ ] the description, pages _____.
[ ] the claims, Nos. _____.
[ ] the drawings, sheets/fig _____.

3. [ ] This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

1. STATEMENT

Novelty (N)	Claims _____	YES
	Claims 1, 2, 8, 9, 12, 13	NO
Inventive Step (IS)	Claims _____	YES
	Claims 3 - 7, 10, 11, 14	NO
Industrial Applicability (IA)	Claims 1 - 14	YES
	Claims _____	NO

2. CITATIONS AND EXPLANATIONS

1. The following documents (D) are relevant:

D1 ..... Patent Abstracts of Japan, vol. 94, no. 011 & JP-A-06312101
D2 ..... DE-A-4 122 369
D3 ..... CH-A-666 199
D4 ..... DE-B-1 253 673
D5 ..... US-A-5 013 492

Each of these documents discloses a fluid-fluid contacting apparatus with a structured packing comprising a number of packing elements arranged in succession in the designed direction of flow.

2. Document D1 comprises a number of layers as defined in the first part of claim 1 and has means at the interface between successive elements for reducing the pressure drop imposed on the continuous phase a the interface. This is achieved, according to D1, by either introducing liquid flow acceleration means (101, 102, 103) between

adjacent packing elements or by modifying the shape of the layer material of the packing element at the lower end of the packing element.

Consequently, D1 takes away the novelty of the subject-matter defined in claims 1, 2, 8, 9 and 12.

3. Document D2 also discloses the provision of means for reducing the pressure drop at the interface between adjacent packing elements. These means may constitute the end portion of a packing element (column 2, lines 44 - 53).

D2 anticipates the subject-matter of claims 1 to 4, 8, 12 and 13.

4. D3, D4 and D5 are of similar relevance. D3 teaches to provide intermediate plates between the packing elements; see in particular claims 1 to 6 of D3. D4 proposes to introduce gaps between the packing elements (see the paragraph bridging columns 5 and 6) and D5 also suggests to modify the end portions of the packing elements (see abstract).

5. The problem of the pressure drop at the interface between adjacent packing elements has obviously be known before, and the solutions suggested in the available prior art are those defined in the claims referred to above. In view of this prior art teaching, it is obvious for the ordinarily skilled worker to modify the known solutions to the problem, according to the circumstances, without the exercise of an inventive skill. It appears that such normal routine work would result in the modifications as defined in the remaining dependent claims.

Therefore, it is not apparent how the features of the

remaining dependent claims or of the description could support an inventive step.

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

1. Claim 3 lacks clarity because the "angle of obliquity" is not defined. It should be made clear in the claim how this angle is defined; see for example paragraph 3 of page 1 ("to the horizontal").

2. Claims 8 to 12 lack clarity. The fluid flow control means according to claim 8 is vague and indefinite. According to claim 9, it may be located in the gap or, according to claims 10 and 11, it may be the gap itself.

3. Independent claim 12 lacks clarity. The claim relates to an apparatus (packing element) but is partly defined by process features ("the localised change in configuration is effective to reduce the pressure drop imposed on the continuous phase at the interface"). Such result features are not suitable for defining an apparatus, which should rather be done by constructional features.

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

United States Patent and Trademark Office
(Box PCT)
Crystal Plaza 2
Washington, DC 20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing: 09 May 1997 (09.05.97)	
International application No.: PCT/IB96/01156	Applicant's or agent's file reference: P.6765/Ehph
International filing date: 28 October 1996 (28.10.96)	Priority date: 31 October 1995 (31.10.95)
Applicant: PARTEN, William, David	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International preliminary Examining Authority on:

05 March 1997 (05.03.97)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer:

J. Zahra

Telephone No.: (41-22) 730.91.11

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B01J 19/32 — A1

(11) International Publication Number: WO 97/16247

(43) International Publication Date: 9 May 1997 (09.05.97)

(21) International Application Number: PCT/IB96/01156

(22) International Filing Date: 28 October 1996 (28.10.96)

(30) Priority Data:
9522086.9 31 October 1995 (31.10.95) GB

(71) Applicant *(for all designated States except US)*: SULZER CHEMTECH AG [CH/CH]; Hegifeldstrasse 10, CH-8404 Winterthur (CH).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: PARTEN, William, David [GB/GB]; Northolme, Tame Bridge, Stockgsley, Middlesbrough TS9 5LQ (GB).

(74) Agent: SULZER MANAGEMENT AG; KS/Patente/0007, Zürcherstrasse 12, CH-8401 Winterthur (CH).

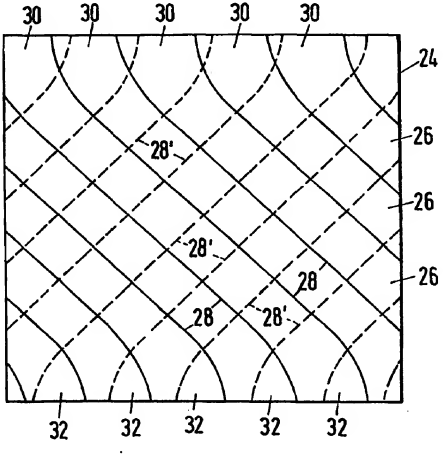
(81) Designated States: AL, AM, AT, AU, AZ, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) **Title:** STRUCTURED PACKING

(57) **Abstract**

Fluid-fluid contacting apparatus (10) is provided with a structured packing comprising a series of packing elements (20) fabricated from sheets (24) of crimped material in such a way that the corrugations (26) in each sheet (24) extend obliquely with respect to the direction of bulk fluid flow through the apparatus (10). Each packing element (20) is oriented with the sheets (24) thereof in a plane which is angularly displaced with respect to the sheets (24) of neighbouring elements (20). Means is provided at or in the vicinity of the interface (21) between neighbouring elements (20) for reducing the pressure drop imposed on the continuous phase as it passes from one element (20) to the next.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	**GB**	United Kingdom	**MW**	Malawi
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BE	Belgium	**HU**	Hungary	**NO**	Norway
BF	Burkina Faso	**IE**	Ireland	**NZ**	New Zealand
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CH	Switzerland	**KZ**	Kazakhstan	**SI**	Slovenia
CI	Côte d'Ivoire	**LI**	Liechtenstein	**SK**	Slovakia
CM	Cameroon	**LK**	Sri Lanka	**SN**	Senegal
CN	China	**LR**	Liberia	**SZ**	Swaziland
CS	Czechoslovakia	**LT**	Lithuania	**TD**	Chad
CZ	Czech Republic	**LU**	Luxembourg	**TG**	Togo
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STRUCTURED PACKING.

This invention relates to fluid-fluid contacting apparatus and, in particular, to structured packings for use in such apparatus. Typically apparatus of the type that the invention relates to is used for operations such as distillation, absorption, scrubbing, stripping, heat exchange etc in which one fluid (eg a liquid) is brought into contact with another fluid (eg a gas) with the fluids usually flowing countercurrent relative to each other. In the case of gas (or vapour)/liquid contacting, the gas constitutes the continuous phase.

The invention is especially concemed with fluid-fluid contacting apparatus in which the structured packing comprises a number of packing elements arranged in succession in the direction of fluid flow through the apparatus which is usually in the form of a vertically disposed column or tower. Each packing element comprises a plurality of crimped sheets of material arranged in face to face relationship with rectilinear corrugations extending obliquely relative to the direction of fluid flow and successive elements are arranged with the sheets in one element angularly displaced with respect to the sheets of the adjacent element(s). Vendors of commercially available packings of this type recommend angular displacements of 90° (Sulzer Brothers Limited) and 70° (Norton Chemical Company).

In their range of packings, one supplier (Sulzer) produces an 'X' range of packings and a 'Y' range of packings. The sheet materials used in the two forms of packings are believed to be identical with respect to surface area and surface treatment but differ by the angle of crimp. In the 'Y' series of packings, the crimp angle is 45° to the horizontal whereas the 'X' series have a crimp angle at 60° to the horizontal.

The 'Y' series packing elements have a higher efficiency but lower capacity than the 'X' series packing elements. The efficiency of a structured packing is a property of the way vapour and liquid contact each other over the whole surface of the packing. The capacity of the packing is set by the capacity at its most restricted elevation. The 'X' series packing elements impose a smaller change in direction on the fluids at the interface due to the larger angle subtended to the horizontal by the crimp angle and therefore have a larger capacity than the equivalent 'Y' series packing elements. The pressure drop within the 'Y' series packing elements is greater and the use of the surface area for mass transfer is greater, hence the 'Y' series packing elements have a higher efficiency.

Recent indications suggest that the capacity of a structured packing is governed by the behaviour of the fluids at the interface between successive packing elements. For instance, where liquid-vapour contact is involved, the pressure drop in the vapour phase is higher at the interface between successive packing elements where the liquid and vapour are forced to move through a change in direction, than in the body of each packing element and, as a result, liquid tends to build up at the interface. The build up of liquid occurs over a greater range of the operating conditions the higher the liquid load. It is therefore assumed that the widely recognised affect of loss of performance in structured packing at higher pressure is due to a build up of liquid at the interfaces between successive packing elements leading to maldistribution of the liquid into the next packing element in the direction of liquid flow.

According to one aspect of the present invention there is provided fluid-fluid contacting apparatus in which the structured packing comprises a number of packing elements arranged in succession in the designed direction of fluid flow, each packing element comprising a plurality of crimped sheets of material arranged in face to face relationship with the corrugations extending obliquely relative to the direction of fluid flow, successive elements being arranged with the sheets in one element angularly displaced with respect to the sheets of the adjacent element(s), characterised by the provision of means at or in the vicinity of the interface between successive elements for reducing the pressure drop imposed on the continuous phase at the interface.

In this manner, it is possible to secure good efficiency without unduly sacrificing capacity (and vice versa). Said means may have the effect of generally smoothing the rate of change of pressure throughout the packed section of the apparutus without necessarily reducing the overall pressure drop across the packed section (although such overall pressure drop may occur). In particular, said means serves to reduce the rate of change of pressure at and in the immediate vicinity of said interfaces.

Such means may be implemented by configuring the corrugations in the sheets so as to secure reduced pressure drop.

In one embodiment , instead of employing rectilinear corrugations, at least some (preferably the majority if not all) of the sheets of each packing element have at least some (preferably the majority if not all) corrugations whose angle of obliquity varies between opposite faces of the packing element such that the angle of obliquity is greater in the vicinity of at least one (preferably both) of said faces than the greatest angle of obliquity within the body of the packing element.

By "angle of obliquity" at a particular point along the length of a corrugation, we mean the angle between the axis of the corrugation at that point and a plane containing said point and parallel to said opposite faces.

Thus, in a typical implementation of this embodiment, each sheet of a packing element may be provided with corrugations which impart a change in flow direction as fluid flows through the body of the packing element from one face to the opposite face, the corrugations having a terminal portion or portions (depending on whether the particular corrugation extends to one or both of said opposite faces) which intersect said faces at an angle of up to 90° while the intermediate portions of each corrugation over at least part of the length thereof extend at an angle somewhat less, eg typically less than 60°.

The angle of obliquity of each such corrugation preferably changes progressively in the lengthwise direction although we do not exclude the possibility of the change being of a discontinuous nature.

By imparting a variable angle of obliquity to the sheets of the packing elements, mass transfer within the heart of each packing element can be maximised and the use of a higher angle of obliquity in the vicinity of the packing element avoids an extreme change in direction as the fluids pass from one packing element to the next.

In another embodiment of the invention, said means at or in the vicinity of the interface between successive elements for reducing pressure drop at the interface may be implemented by producing at least some (preferably the majority if not all) of the corrugations in at least some (preferably the majority if not all) of the sheets of each packing element with a reduced cross-section in the vicinity of a least one (preferably both) of the faces of the packing element thereby reducing the surface area and pressure drop at such location.

The localised reduction in cross-sectional area of the corrugations may be effected by a reduction in depth. The reduction in depth is preferably progressive as the corrugations approach the end faces of the packing elements.

If desired, such localised reduction in the cross-sectional area of the corrugations may be combined with variation in the angle of obliquity as described above or the reduction may be employed with corrugations which are otherwise of conventional configuration. The reduction in cross-sectional area or depth may take place progressively and may be to such an extent that the corrugations terminate short of the edges proper of the sheets, ie so that marginal edges of the sheets are flat (non-corrugated). Because a reduction in depth will result in the sheets being out of contact with one another, if desired or necessary means may be provided for supporting the sheets in spaced relation with each other and/or increasing the rigidity of the structure in the regions where the depth of the corrugations is reduced. Such means may comprise spacer elements extending between adjacent sheets or the sheets may be provided with formations along those edges which border the interfaces between adjacent packing elements, which formations may be designed to co-operate (eg interdigitate) at the interface to maintain sheet spacing and/or enhance rigidity.

In yet another embodiment of the invention, said means at or in the vicinity of the interface between successive elements for reducing pressure drop at the interface may be implemented by provision of fluid flow control means between successive packing elements whereby the localised direction of flow of fluid leaving one packing element is rendered more compatible with the next packing element so as to reduce the pressure drop.

In this instance, the successive packing elements are spaced apart from one another in the direction of bulk fluid flow through the apparatus and the fluid flow control means is located in the gap. Such control means may comprise an open structure having a series of walls which extend between successive packing elements and which may for instance be generally parallel with one another and/or be arranged in two sets with one set of walls intersecting the other. Thus, for example, the control means may comprise an open grid structure having cells through which fluid exiting one packing element passes before entering the next packing element, the cells having axes which are substantially parallel to the direction of bulk flow of fluid through the apparatus or at least more closely in parallelism with direction of said bulk flow than said corrugations. Alternatively the control means may comprise an arrangement of regularly or irregularly shaped objects, such as Raschig and/or Pall rings, preferably oriented with the major part of their surface areas extending predominantly in the direction of said direction of bulk flow so that the fluid passing from one packing element to the next has a flow direction which is predominantly parallel with said direction of bulk flow.

In a further embodiment of the invention, said means at or in the vicinity of the interface between successive elements for reducing pressure drop at the interface may be implemented by provision of a gap between successive packing elements. In this embodiment, the packing elements may be supported in spaced relation with a gap therebetween sufficient to secure a significant reduction in the pressure drop imposed on the continuous phase as it passes from one packing element to the next. Preferably the gap, ie the perpendicular distance between planes containing the extremities of successive packing elements at each interface, is at least 2 cm, more usually at least 4 cm. Where the packing elements are separated from one another in this way, without any intervening structure such as a support grid between them, it may be desirable to control the descending liquid phase so as to promote efficient transfer from one packing element to the packing element below otherwise there may be a tendency for the liquid phase to run along the sheet edges at the interface with the possibility of maldistribution. For instance, the sheet edges at the lower faces of the packing elements may be contoured to promote collection of the liquid at well-defined sites so that the liquid phase then drips from these sites on to the packing element below. Thus, for example, the sheet edges at the lower faces may have a zigzag configuration so that the liquid phase collects, and drips, from the apices. It will be appreciated that the zigzag configuration will be such that a large number of drip sites are distributed substantially uniformly across the interface.

The materials of fabrication of the sheets may be selected from those usually employed in structured packing, eg thin foil-like materials (metal or otherwise), gauze materials, etc. The sheets may be perforated to allow passage of fluid from one side of the sheet to the other as the fluids flow through the packing.

The surface of the sheet material may be smooth or it may be textured by any appropriate technique to improve its wetting, liquid distribution and cross-mixing properties for example.

The profile of the corrugations in cross-section may take various forms commonly used in structured packings, eg semi-circular, V-shaped etc. Likewise, the dimensions of the corrugations may be generally the same as used in commercially available structured packing such as sold by Sulzer and Norton Chemical Company. The corrugations need not necessarily be continuous throughout the packing element. For instance, as used in a commercially available structured packing, the corrugations may be interrupted within the body of the packing element for example in such a way that a first series of corrugations extend part-way through the element and a second series of corrugations then succeed said first series and extend through the remainder of the element, the peaks and troughs of the first series being laterally offset relative to those of the second series and apertures being formed in the sheets at the junctions between the two series whereby fluids can pass from one side of the sheet to the other.

Mass transfer at the interfaces may be reduced at the interfaces between packing elements in accordance with the present invention. Consequently the depth dimension (as considered in the direction of bulk flow through the apparatus) of a packing element in accordance with the invention when optimised with respect to efficiency may differ from that of (and typically be greater than) a conventional structured packing element having the same efficiency.

The invention will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1 is a digrammatic view of a packed column;

Figure 2 is a fragmentary view of a packing element schematically showing the configuration of the corrugations in adjacent sheets;

Figure 3 is a fragmentary view showing (a) the corrugation profil at a location inwardly removed from the interface between adjacent packing elements, and (b) the corrugation profil at a location immediately adjacent the interface;

Figure 4 is a fragmentary view showing an alternative embodiment;

Figure 5 is a fragmentary view showing an embodiment corresponding to the embodiment of Figure 3; and

Figure 6 is a fragmentary view showing an embodiment corresponding to the embodiment of Figure 4.

Referring to Figure 1, the invention will be decribed with reference to a packed column or tower 10 for use in for example mass transfer or heat exchange between a descending liquid phase and an ascending vapour phase. At its upper end, the column 10 is provided a liquid distributor 12 and a vapour outlet 14. At its lower end, the column is provided with a vapour inlet 16 and a liquid outlet 18. A number of structured packing elements 20 stacked vertically above a support 22. Each packing element comprises a series of parallel sheets or lamellae arranged in planes extending substantially vertically with the sheets in each packing element disposed at an angle to those in the adjacent packing element(s). This angle may be 90° for instance but other angles are possible. The packing elements are fabricated so that they extend across substantially the full width of the column and are of a convenient depth for installation, typically 30 cm deep. Each packing element in the embodiment of Figure 1 is located in abutting relation with its neighbours with interfaces 21 between them.

Referring to Figure 2, each sheet or lamella 24 is formed with a series of corrugations 26 with peaks or crests 28 extending generally obliquely between the upper and lower faces of the respective packing element and adjacent sheets are oriented with the corrugations thereof intersecting in criss-cross fashion. Adjacent sheets contact each other at the points of intersection between the peaks of one sheet and those of the neighbouring sheets. In contrast with commercially available structured packings, the corrugations are not rectilinear along their entire length - instead each corrugation 26 has a terminal portion or portions 30, 32 (depending on whether it extends to just one or both of the upper and lower faces of the packing element) disposed at a different angle to the intermediate portion of the corrugation. As shown the corrugations 26 change direction progressively between the upper and lower faces of the packing elements such that the terminal portions 30, 32 have axes which are substantially perpendicular to those faces while the intermediate portions are inclined to the vertical. In Figure 2, the solid lines depict the peaks 28 of the corrugations in the face of the sheet presented to the viewer while the broken outlines 28' depict the peaks of the corrugations in the corresponding face of the sheet immediately behind the one in view. Although in Figure 2, the terminal portions 30, 32 of the corrugations intersect the upper and lower faces substantially perpendicularly, it will be understood that the advantages of the invention may still be secured even if the angle of intersection is less than 90°.

Referring to Figure 3, in this embodiment the corrugations may be oriented generally as shown in Figure 2 or they may be of the rectilinear configuration used in commercially available structured packing such as the 'X' or 'Y' series packing elements manufactured and sold by Sulzer Brothers Limited. Reduced pressure drop is secured or enhanced in this case by reducing the depth of the corrugations in the vicinity of the interfaces 21 of the packing elements (see Figure 1). Thus, the profile shown at (a) in Figure 3 represents the corrugation shape at locations inwardly removed from the interfaces 21 of the packing element while the profile shown at (b) represents a reduced depth corrugation shape at or immediately adjacent the interfaces 21. It will be understood that the reduction in depth will mean that the adjacent sheets will no longer have

peak to peak contact with one another in these regions. If necessary, spacers or the like (not shown) may be provided to maintain uniform spacing between the sheets and/or enhance rigidity of the structure where peak to peak contact does not exist.

In the embodiment of Figure 1, the structured packing elements 20 are vertically stacked in abutting face to face relation. However, as indicated in Figure 4, the packing elements 20 (which may comprise commercially available elements such as those described previously) are arranged in vertically spaced relation to reduce pressure drop between successive packing elements, fluid control means 40 are located between successive packing elements in order to render the fluid flow from one packing element more compatible with the orientation of the next packing element. The fluid control means may as shown be in the form of an open grid structure with the cells of the grid having walls whose surfaces lie in substantially vertically extending planes so that liquid and vapour exiting one packing element at an angle imposed by the obliquely extending corrugations is constrained to pass through the grid structure before entering the next packing element. In this way, the angle of exit flow is modified so as to be substantially vertical before the liquid and vapour enters the differently orientated corrugations of the next packing element. Although not shown in this way, the corrugations in the packing elements and the grids may be so arranged that the cells in the grids effectively form continuations of the corrugations and serve to smoothly deflect flow of the continuous phase from one packing element towards a flow direction corresponding to the orientation of the corrugations in the next packing element.

Although the invention is described with reference to vapour-liquid contacting, we do not exclude the possibility of other forms of fluid-fluid contact, particularly liquid-liquid contact where one liquid, usually the less dense liquid, forms the continuous phase.

Corresponding to Figure 3, Figure 5 shows an embodiment with rectilinear corrugations 26 and terminal portions 32 adjacent the interface 21 with reduced depth corrugation shape. The depth of the corrugations 26 is a, the reduced depth at the interface 21 is b. At any height of the terminal portions 32, the total length of the crimped sheet (i e the length of unwinding of any horizontal intersection line) is equal to the corresponding length of the corrugations 26.

Corresponding to Figure 4, Figure 6 shows an embodiment with fluid control means 40 located between successive packing elements 20 in form of a grid. The square-shaped cells form a continuation of the corrugations.

CLAIMS

1. Fluid-fluid contacting apparatus in which the structured packing comprises a number of packing elements arranged in succession in the designed direction of fluid flow, each packing element comprising a plurality of crimped sheets of material arranged in face to face relationship with the corrugations extending obliquely relative to the direction of fluid flow, successive elements being arranged with the sheets in one element angularly displaced with respect to the sheets of the adjacent element(s), characterised by the provision of means at or in the vicinity of the interface between successive elements for reducing the pressure drop imposed on the continuous phase at the interface.

2. Apparatus as claimed in Claim 1 in which said means is constituted by a localised change in the configuration of the corrugations immediately adjacent the interfaces.

3. Apparatus as claimed in Claim 2 in which at least some of the sheets of each packing element have at least some corrugations whose angle of obliquity varies between opposite faces of the packing element such that the angle of obliquity is greater in the vicinity of at least one of said faces than the greatest angle of obliquity within the body of the packing element.

4. Apparatus as claimed in Claim 3 in which the corrugations have a terminal portion or portions which intersect said faces at an angle of up to 90° while the intermediate portions of each corrugation over at least part of the length thereof extend at an angle somewhat less.

5. Apparatus as claimed in Claim 3 or 4 in which the angle of obliquity of each such corrugation changes progressively in the lengthwise direction.

6. Apparatus as claimed in any one of Claims 1 to 5 in which at least some of the corrugations in at least some of the sheets of each packing element are formed with a reduced cross-section in the vicinity of a least one of the faces of the packing element thereby reducing the surface area and pressure drop at such location.

7. Apparatus as claimed in Claim 6 in which at least some of the corrugations have a localised reduction in depth in the vicinity of a least one of the faces of the packing element.

8. Apparatus as claimed in any one of Claims 1 to 7 in which said means at or in the vicinity of the interface between successive elements for reducing pressure drop at the interface comprises fluid flow control means.

9. Apparatus as claimed in Claim 8 in which the successive packing elements are spaced apart from one another in the direction of bulk fluid flow through the apparatus and said fluid flow control means is located in the gap.

10. Apparatus as claimed in Claim 1 in which said means at or in the vicinity of the interface between successive elements for reducing pressure drop at the interface comprises a gap effective to produce a significant reduction in the pressure drop imposed on the continuous phase at the interface.

11. Apparatus as claimed in Claim 10 in which said gap is at least 2 cm.

12. A structured packing element comprising a plurality of crimped sheets of material arranged in face to face relationship with the corrugations extending obliquely relative to the direction of fluid flow, successive elements being arranged with the sheets in one element angularly displaced with respect to the sheets of the adjacent element(s), the corrugations having a localised change in the configuration of the corrugations immediately adjacent at least one face of the element whereby, when two such elements are located face to face, the localised change in configuration is effective to reduce the pressure drop imposed on the continuous phase at the interface.

13. An element as claimed in Claim 10 in which said localised change in configuration comprises a change in the angle of obliquity in the vicinity of at least one of the faces of the element such that the angle of obliquity is greater at such location than at locations inwardly removed from said one face.

14. An element as claimed in Claim 10 in which said localised change in configuration comprises a reduction in the depth of the corrugations in the vicinity of at least one of the faces of the element.

Fig.1

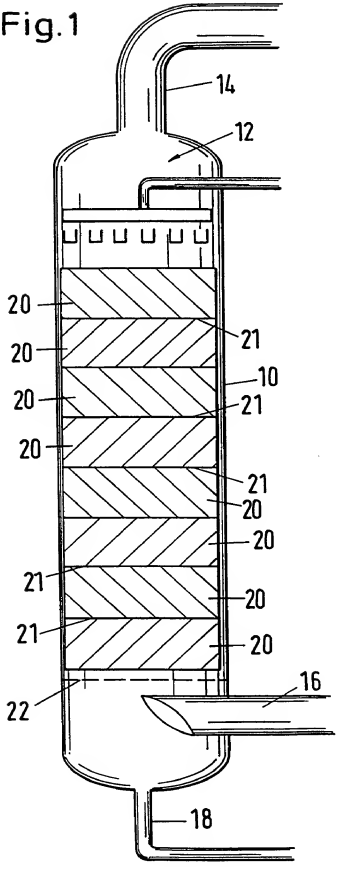


Fig.4

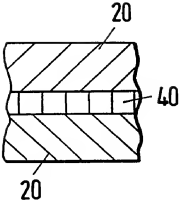


Fig. 2

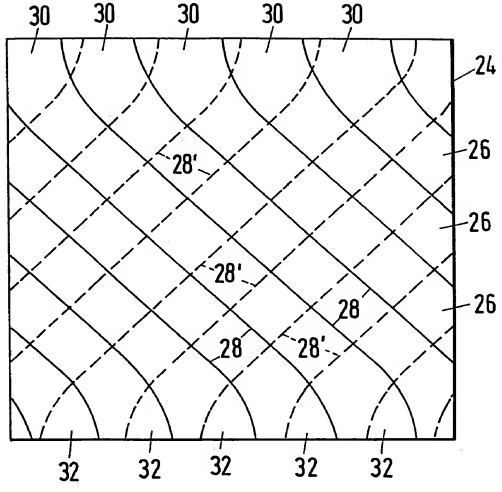


Fig. 3

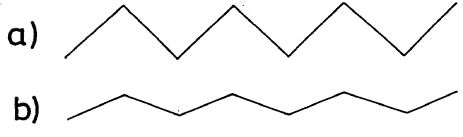


Fig.5

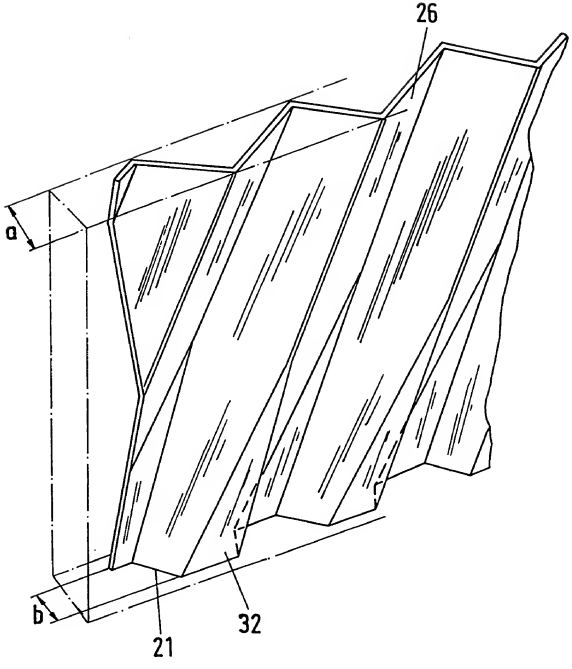
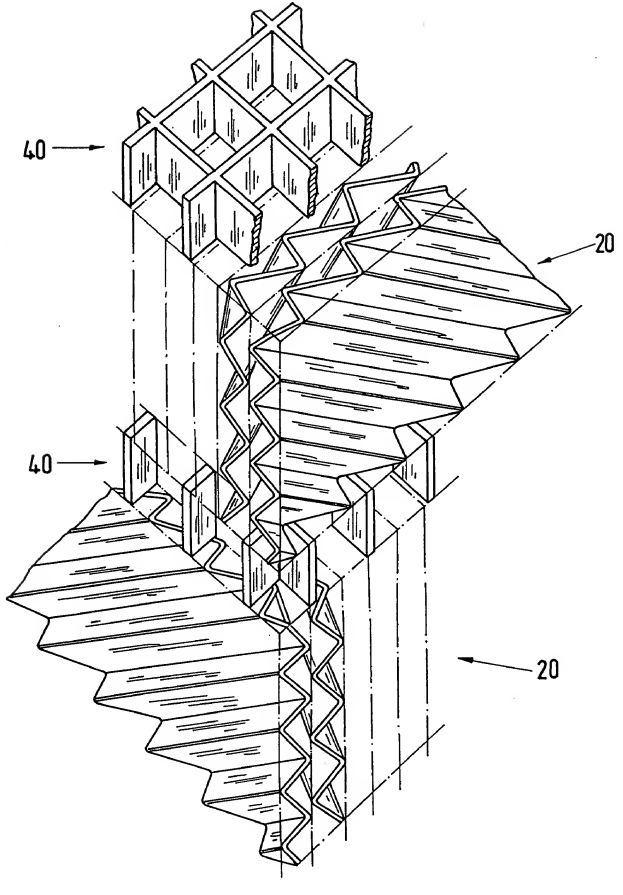


Fig. 6



INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB 96/01156

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B01J19/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE,C,41 22 369 (RAINER RICHTER GMBH) 22 October 1992 see abstract see column 2, line 44 - line 53 see column 3, line 35 - line 64 see figures	1-4,8, 12,13
A	---	5
X	US,A,5 013 492 (MUNTERS CORPORATION) 7 May 1991 see abstract see column 1, line 62 - line 66 see column 2, line 15 - line 19 see column 2, line 59 - column 4, line 9	1,2,8,12
A	---	
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
22 January 1997	31.01.97
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Authorized officer Stevnsborg, N

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	PATENT ABSTRACTS OF JAPAN vol. 94, no. 011 & JP,A,06 312101 (HITACHI LTD.), 8 November 1994, see abstract; figures & DATABASE WPI Section Ch, Week 9504 Derwent Publications Ltd., London, GB; Class E11, AN 95-027321 & JP,A,06 312 101 (HITACHI LTD.) , 8 November 1994 see abstract	1,2,8,9, 12
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A	EP,A,0 401 682 (MUNTERS EUROFORM GMBH) 12 December 1990 see abstract see column 2, line 19 - line 22 see column 2, line 39 - line 53 see figures	1,3-5, 12,14

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US-A-4225540	30-09-80	NONE	
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